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PATENT SPECIFICATION

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(54) ICE CREAM

(71) We, UNILEVER LIMITED, a company organised under the laws of Great Britain, of Unilever House, Blackfriars, London, E.C.4, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to ice cream.

Conventional ice cream is prepared by a process involving freezing and then hardening to temperatures in the order of −20°C to −40°C. The product characteristics required for a conventional ice cream will depend on the personal tastes of the consumer and ice creams are formulated to meet a variety of such tastes; the formulation of any one conventional ice cream will depend on the tastes of the consumers concerned.

One characteristic of ice cream that has been recognised in relation to the present invention as being important is the log C, as defined later, of the ice cream. In the UK from our measurements conventional ice creams have log Cs at −20°C, after hardening at the lowest of 2.9 (and at the highest of 3.7) but usually in the range of 3.0 to 3.4. (A technique for measuring C and hence log C is described later in the specification.) C values will be taken after hardening conventionally as indicated and as for instance described in the standard text-books.

It has been found that an ice cream spoonable at −20°C has major advantages over conventional ice cream in particular in that it is more readily spoonable at deep-freeze temperatures and so can be served more readily direct from the deep freeze. A correlation has been found to exist between spoonability and log C and it has been found that, for an ice cream to be spoonable, its log C at −20°C should be less than that of conventional ice cream, i.e. less than 2.9 and preferably less than 2.8, particularly preferably less than 2.5.

The invention therefore provides a hardened ice cream with a log C at −20°C of less than 2.9.

Conveniently such an ice cream can be achieved by addition of freezing-point depressants to the formulation of a conventional ice cream, at the expense of water, in amounts sufficient to lower the log C at −20°C by between 0.25 and 1, preferably by 0.4 to 0.75.

In general more freezing-point depressants will be used than in conventional ice creams. Preferred freezing-point depressants are monosaccharides and low molecular-weight alcohols (i.e. molecular weights less than 200), preferably polyalcohols and in particular glycerol and sorbitol. The freezing-point depressant or depressants should preferably be such that the product has the desired (by the consumer) sweetness as well as the desired spoonability at −20°C.

It has further been found that locust bean gum is a preferred thickening agent for ice cream according to the invention particularly when in combination with one or more thickening agents. Compared with use of other thickening agents the use of locust bean gum, particularly with suitable other thickening agents, gives the possibility of obtaining ice creams according to the invention with improved stand-up and melt-down characteristics without disadvantageously affecting, to a significant extent, the spoonability at −20°C or the organoleptic properties at eating temperature (e.g. −10°C).

Preferred ice creams have a shape factor greater than 65% particularly greater than 70% after 2 hours and a melt-down of less than 25 ml/hr at 15°C as defined later.

The amount of locust bean gum should preferably be, by weight of the ice cream, in the range 0.05% to 0.5%, particularly preferably in the range 0.15% to 0.25%.

A preferred thickening agent to be used with locust bean gum is dextran. Dextran is a generic term for a group of polysaccharides commonly synthesised by certain bacteria from sucrose as explained in Glicksman M., Gum Technology in the Food Industry, Academic Press, 1969 at pages 335 to 339. Examples of dextrans that can be used in an ice cream according to the present invention include the dextran reference No. 1527d sold by

Koch-Light Laboratories Ltd. as having a molecular weight 5 million—40 million. (This is produced by cultivation of the Northern Region Research Iaboratory strain B-512(S) of Leuconostoc mesenteroides as described in Glicksman M., Gum Technology in the Food Industry, Academic Press, 1969, page 337.) Another example of a commercially available dextran is the dextran sold by Honeywell-Stein as having a molecular-weight 2 million to 5 million. For more details of suitable dextrans reference should be made to the textbook by Glicksman referred to above and in particular to US 2,823,128 especially column 1 line 24 to column 2 line 55.

The amount of dextran used should preferably be, by weight of the ice cream, at least 0.05%, particularly preferably at least 0.1%. The upper limit will be determined by cost and 0.5% can be treated as an upper limit on this basis although normally there will be no point in using more than 0.3%.

It should be noted that even with products according to the preferred form of the invention (use of dextran+LBG) the log C at −20°C should preferably not be below 2.3 otherwise the eating properties at −10°C will tend not to be comparable with a conventional ice cream.

It is a particular advantage of the present invention, particularly when dextran and locust bean gum are used, that the growth of ice crystals is retarded. Such growth is particularly a problem in the presence of freezing-point depressants such as glycerol and sorbitol. The texture and quality of the product is safeguarded even when it is subjected to storage in display cabinets (where the temperature, although theoretically about −18°C, in practice is frequently higher), transport home and then storage under domestic conditions for instance in the freezer compartment of a refrigerator where again temperatures vary, frequently involving freeze-thaw cycles.

A further feature of the present invention is the appreciation that one general class of thickening agents that can advantageously be used with locust bean gum is the class of polysaccharide that meet the test given later in the specification. Most if not all dextrans meet this test.

It is believed that such soluble, non-gel forming polysaccharides as dextran act by reducing the amount of free water available in the system and thereby strengthening the structure of the system in particular the structure formed by such gel-forming polysaccharides as locust bean gum. At least many gel-forming polysaccharides are mixed polysaccharides (i.e. polysaccharides in which a series based on one saccharide unit is followed by a series based on another saccharide unit and so one in a regular manner).

It has further been found that starches, in particular modified starches such as the modified starch sold by Laing National under the trade name "Instant Cleargel" and believed to be adipate/acetate modified waxy maize starch, can usefully be incorporated as an additional thickening agent. Such starches in particular modified starches like "Instant Cleargel" improve the thickness of the ice cream without leaving a cloying taste on the palate. The amount of the modified starch should preferably be, by weight of the ice cream, in the range 0.05 to 0.4%, most preferably in the range 0.08 to 0.2%.

Other than in the use of sufficient freezing point depressant and of a thickening agent comprising particular components no especial insight is required in the formulation or processing of ice creams according to the invention. Both conventional components and processing conditions for ice cream can, for instance, be used. Such components and conditions can be found in the usual trade publications and text books. Particularly useful in this respect is Arbuckle, "Ice Cream", 1972 (2nd Edition), AVI Publishing Corp., Westpoint, Conn.

The invention will now be illustrated further by the following examples.

Example 1 and Comparisons A and B

The following formulations were used (Comparison A is a standard UK dairy ice cream formulation), percentages are by weight:

Ingredients	Example 1	Comparison A
Spray-dried skim milk	10	10
Sucrose	15	15
Corn sugar solids	3	3
Locust bean gum	0.2	0.2
Dextran*	0.15	
Instant Cleargel	0.1	
Carageenan	0.02	0.02
Glycerol	3	
Monoglyceride (emulsifier)	0.5	0.5
Milk fat	6.5	6.5
Water to	100	100

* Dextran 1527d supplied by Koch-Light Laboratories Ltd.

The products were prepared in the same, standard way to about 100% overrun.

The following table gives the results obtained on Example 1 and Comparison A:

	Melt-Down	Shape-Factor	
	ml/hr	2 hr	4 hr
Example 1	7.38	76.7	53.3
Comparison A	13.5	66.8	54.2

It will be appreciated that a higher melt-down or a lower shape-factor would have indicated that Example 1 was in these respects of poorer quality than Comparison A. Organoleptically Example 1 and Comparison A were comparable. In contrast to Comparison A Example 1 was spoonable at $-20°C$; its log C at $-20°C$ was about 0.5 lower than that of Comparison A.

Example 2

In ice cream was prepared by conventional processing techniques to the following formulation:

Ingredient	% by weight
Made-up skimed Milk	27
Sucrose	13
Glucose syrup	2
Locust bean gum	0.17
Liquid oil blend	9.5
Monoglyceride emulsifier	0.45
Colour and flavour	0.03
Instant Cleargel	0.10
Dextran	0.15
Salt	0.05
Glycerol	3.0
Water to	100

The presence of thickening agents such as dextran, locust bean gum and modified starches can be detected analytically in such a product. The product itself is an excellent ice cream resembling conventional ice cream closely in eating properties but being spoonable at $-20°C$.

Example 3

Example 1 was repeated five times and the average values for melt-down, shape-factor and log C at $-20°C$ were 16 ml/hr; 71 at 2 hours and 50 at 4 hours; and 2.6. The log C at $-20°C$ of Composition A was 3.2.

It should be noted that for an ice cream based on milk-fat the melt-down should preferably be in the range between 5 and 20 ml/hr at 15°C.

Test Methods

Shape Retention and Melt-Down Test

A rectangular block of ice cream of length 13.6 cm, height 4.0 cm and width about 8.8 cm which has been stored at $-20°C$ is placed on a wire gauze (10 wires per inch) in an atmosphere maintained at 15°C. Arrangements are made for collection of the liquid drained from the gauze. After 10 ml of liquid have been collected, the volume of liquid collected in each subsequent 10 minute period is measured and the slope of the graph obtained by plotting volume collected against time is taken as the melt-down (mls/hr). After 2 hours and again after 4 hours thawing the height h and length l of the residue of the brick are measured, and the degree of shape retention is given by the shape factor calculated as $3.4\ h/l\%$. (The factor 2.50 in the priority document is appropriate for the brick referred to in its specification.) The reproducibility of the shape factor measurements with a given ice cream is $\pm 5\%$.

C and Log C

To determine C and hence log C the following method is used:

Principle

The hardness of ice cream is measured by allowing a standard cone to penetrate a sample for 15 seconds using a cone penetrometer. The C-value can be calculated from the penetration depth.

Apparatus:

Ebonite cone

With an apex angle of 40° and the tip blunted by a few strokes on fine abrasive paper to give a flat 0.3 ± 0.03 mm in diameter. Total weight of cone and sliding penetrometer shaft 80 ± 0.3 g; also additional weights of 80 ± 0.3 g.

Penetrometer

This should have a scale calibrated in 0.1 mm., and be fitted with a lens. The penetrometer made by Sommer and Runge, Berlin, is recommended, particularly for static use. The Hutchinson instrument can also be used; it requires no electricity supply, but must be modified for satisfactory operation. The accuracy of penetrometer timing mechanisms must be checked regularly. The use of a $\times 3$ magnification lens of about 6—8 cm diameter fitted to the penetrometer facilitates the setting of the cone tip on the sample surface, and an unfocused light limited to the equivalent of a 1-watt bulb at a distance of about 5 cm (to avoid heating the sample surface) is also advantageous.

Temperature probe

The temperature probe should read to within 0.1°C and have a stem about 1 mm in diameter and about 4 cm long. Its accuracy should be checked regularly in baths of known temperatures.

Tempering facilities

(a) Room controlled at required temperature $\pm 1°C$;

(b) Constant-temperature cabinets, tolerance ±0.2°C. The forced-draught constant-temperature cabinets supplied by Zero N.V. Rotterdam are satisfactory.

Process:

Sampling

Samples should be convenient size and preferably with smooth surfaces to increase accuracy.

Tempering

2 days at whatever temperature is required e.g. −20°C. Measure temperature accurately before penetration.

Measurement

Where possible, penetrations are made in the temperature-controlled room, and should be completed within two minutes of removing the sample from the constant-temperature cabinet.

1. Insert the temperature probe as near horizontally as possible at a few mm below the sample surface, read and note the sample temperature after 30 seconds. (Reject any samples differing by more than 0.5°C from the nominal test temperature.)

2. Place the samples on the levelled penetrometer table.

3. Set the cone tip accurately on the sample surface, using a lens and, if necessary, oblique lighting.

4. Release the arresting device and allow the cone to penetrate the sample for 15 seconds.

5. Read and note the penetration depth.

6. Should the penetration depth be less than 72×0.1 mm (equivalent to a C-value of more than 500 g/cm²) the measurement should be repeated with the cone weight increased by 80 g.

Further 80 g weights may be added as necessary to ensure adequate penetration of the sample and the C-value scale reading corrected accordingly.

7. Penetration measurements should not be made within 2 cm of the sample edge nor within 2.5 cm of each other. Determinations in which air bubbles, cracks, etc. interfere should be rejected.

Calculation of C-values

The C-value can be calculated from the penetration depth using the formula:

$$C=\frac{K\times F}{P^{1.6}}$$

where

C=Yield value or C-value (g/cm²)

F=Total weight of cone and sliding stem (g)*

P=Penetration depth (0.1 mm)

K=Factor depending on cone angle:

Cone angle °	K value
30	9670
40	5840
60	2815
90	1040

* Depending on the likely softness of the product, the cone weight should be adjusted, e.g.

at −10°C	use 80 gm
at −15°C	use 160 gm
at −20°C	use 240 gm

i.e. it depends on temperature of measurement.

Polysaccharide Test

To test whether a given thickener X will be effective with LBG in a spoonable ice cream according to this aspect of the invention prepare three solutions as follows, parts by weight:

1. 14 parts water
   21 parts sucrose
   0.175 parts locust bean gum
2. 14 parts water
   21 parts sucrose
   0.175 parts locust bean gum
   X at a level between 0.05 and 3 parts
3. 14 parts water
   21 parts sucrose
   X at the same level as in 2

Cool all three to −14°C and then warm them to 0°C. If 3 is a viscous liquid and 2 is a thicker gel than 1, then X is an effective thickener to use with locust bean gum in an ice cream according to the invention.

For preferred thickeners for use with LBG in an ice cream according to the invention, the bulk modulus of (2) will be greater than 1000 dynes/cm² and the bulk modulus of (3) will be less than 50 dynes/cm². The bulk modulus can be measured using an elastometer. Where X is the dextran used in Example 1 the bulk modulus of (2) was 2400 dynes/cm² and the bulk modulus of (3) was 0. The bulk modulus of (1) was 120.

WHAT WE CLAIM IS:—

1. A hardened ice cream with a log C at −20°C of less than 2.9.

2. An ice cream as claimed in Claim 1 with a log C at −20°C of less than 2.8.

3. An ice cream as claimed in Claim 2 with a log C at −20°C of less than 2.5.

4. An ice cream as claimed in any one preceding Claim in which the log C is not below 2.3.

5. An ice cream as claimed in any one pre-

ceding Claim containing a monosaccharide or a low molecular weight alcohol.

6. An ice cream as claimed in Claim 5 in which the low molecular-weight alcohol is a polyalcohol.

7. An ice cream as claimed in Claim 6 in which the polyalcohol is glycerol.

8. An ice cream as claimed in Claim 6 in which the polyalcohol is sorbitol.

9. An ice cream as claimed in any one preceding Claim formulated by the addition of freezing-point depressants to the formulation of a conventional ice cream, at the expense of water, in amounts sufficient to lower the log C at −20°C by between 0.25 and 1.

10. An ice cream as claimed in Claim 9 in which the amounts are sufficient to lower the log C at −20°C by 0.4 to 0.75.

11. An ice cream as claimed in any one preceding Claim containing the thickening agent locust bean gum.

12. An ice cream as claimed in Claim 11 in which the amount of locust bean gum, by weight of the ice cream is in the range 0.05% to 0.5%.

13. An ice cream as claimed in Claim 12 in which the amount is in the range 0.15% to 0.25%.

14. An ice cream as claimed in any one of Claims 11 to 13 containing at least one other thickening agent as well as locust bean gum.

15. An ice cream as claimed in Claim 14 containing a polysaccharide thickening agent that fulfills the polysaccharide test herein defined.

16. An ice cream as claimed in Claim 15 in which the bulk modulus at 0°C of a solution consisting of the further thickening agent, 14 parts water, 21 parts sucrose and 0.175 parts locust bean gum after cooling to −14°C and warming to 0°C is greater than 1000 dynes/cm² and the bulk modulus at 0°C of the same solution treated in the same way except that it contains no locust bean gum is less than 50 dynes/cm².

17. An ice cream as claimed in Claim 15 or Claim 16 in which the polysaccharide thickening agent is dextran.

18. An ice cream as claimed in any one of Claims 11 to 14 containing as a thickening agent dextran.

19. An ice cream as claimed in Claim 17 or Claim 18 in which the dextran is produced by cultivation of the Northern Region Research Laboratory strain B-512(S) of Leuconostoc mesenteroides on sucrose.

20. An ice cream as claimed in any one of Claims 17 to 19 in which the amount of dextran, by weight of the ice cream, is at least 0.05%.

21. An ice cream as claimed in Claim 20 in which the amount is at least 0.1%.

22. An ice cream as claimed in Claim 21 in which the amount of dextran, by weight of the ice cream, is not more than 0.5%.

23. An ice cream as claimed in Claim 22 in which the amount is not more than 0.3%.

24. An ice cream as claimed in any one of Claims 14 to 23 containing the thickening agent carrageenan.

25. An ice cream as claimed in any one preceding Claim containing a modified starch.

26. An ice cream as claimed in any one preceding Claim with a shape factor as herein defined greater than 70% after 2 hours at 15°C.

27. An ice cream as claimed in any one preceding Claim with a melt-down as herein defined of less than 25 ml/hr at 15°C.

28. An ice cream as claimed in any one preceding Claim based on milk fat.

29. An ice cream as claimed in Claim 28 with a melt-down between 5 and 20 ml/hr at 15°C.

30. An ice cream as claimed in Claim 1 substantially as described with particular reference to Example 1.

31. An ice cream as claimed in Claim 1 substantially as described with particular reference to Example 2.

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